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AD 417768

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SAMUEL FELTMAN AMMUNITION LABORATORIES

PICATINNY ARSENAL
DOVER, N. J.

FRAGMENTATION TEST

RECORD NO. 287

DATE August 1954

SUBJECT:

Shell, HE, 60 mm, Folding Fin, Typed BD-106-1, Metal Parts Assembly

GFlartey/hb/4160
Picatinny Arsenal, Dover, N.J.
6 August 1954

TEST RECORD NO: 287

REFERENCE: Project No. Tal-1402

DESCRIPTION OF AMMO: Shell, HE, 60 mm, Folding Fin Type BD-106-1, manufactured by the Budd Company from Steel, Carbon, Bar Stock, AISI 1020, Spec QQ-S-633.

DRAWING NUMBERS:
Complete Round: WS-5154X, Rev 1/21/54
Shell Loading: WD-5196X, WD-5197X, 2/5/54
Shell Metal Parts: WB-5152- -X, Rev 1/12/54
(Assembly & Details)

QUANTITY IN LOT: 3 in each lot

QUANTITY FRAGMENTED: 6

METHOD FUNCTIONING: Modified M52 Fuze, Drawing 73-1-161, initiated with Corps of Engineering blasting cap.

PURPOSE OF TEST: The object of this test was: (a) to compare the fragmentation properties of TNT-loaded type BD-106-1 folding fin Shell metal parts with those of the Comp B Type BD-106-1 folding fin Shell metal parts and (b) to compare the fragmentation properties of the Type BD-106-1 Shell (both TNT and Comp B-loaded) with those of similarly loaded Shell, HE, 60 mm T24.

FRAGMENTATION PROCEDURE: 6 Shell were fragmented at ambient temperature. (3 shell TNT-loaded, 3 shell Comp B-loaded). The shell were assembled equipped with electric ignition and placed in a pine box with ½" wall thickness. The overall dimensions of the box were 8" x 8" x 16". The box was placed on end over 6' of sawdust in a 14' - 9" deep fragmentation tub, 15' - 5" in diameter at the top and tapering to 13" diameter at the bottom. The box was covered with 5' of sawdust.

FRAGMENTATION RECOVERY & CLASSIFICATION:

Fragments were recovered from tub by sifting the sawdust on a mechanically-operated screen of No. 8 Mesh (.093" opening, .032 wire diameter), using a magnetic separator. The fragments were classified by weight and grouping according to the following weight zones:

Group 0 - 0 to ½ grain

54AA 60589

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Group 1 - ½ to 2 grains
Group 2 - 2 to 5 grains
Group 3 - 5 to 10 grains
Group 4 -10 to 25 grains
Group 5 -25 to 50 grains
Group 6 -50 to 75 grains
Group 7 -75 to 150 grains
Group 8 -150 to 750 grains
Group 9 -750 to 2500 grains
Group 10-Over 2500 grains

The 60 mm mortar shell metal parts assemblies, Type BD-106-1 which were fragmented during the course of this test were of two-piece silver soldered base plug construction as shown on Drawing No WB-5152- -X, Rev 1/12/54. The complete round assembly fragmented consisted of both the shell body and folding fin and boom assembly. The folding fin and boom assembly (integral) was attached to the threaded end of the base plug on the shell body. The fin and boom assemblies were manufactured from aluminum alloy, 24 ST - 4, Spec QQ-A-354a. The steel and aluminum fragments were recovered, segregated into two groups, counted, and recorded separately. The steel fragments were recovered by means of a magnetic separator and the aluminum fragments were recovered manually.

Discussion & Conclusions:

Based on the limited data available, the following observations were made:

Considering the opinion that effective lethality is obtained only with fragments occurring over 10 grains in size, Comp B-loaded shell produced a greater total number of effective fragments than the TNT-loaded shell.

The average total number of Comp B-loaded steel shell fragments occurring above 10 grains is 454 and the average total number of TNT-loaded steel shell fragments occurring above 10 grains is 399.

The average total number of Comp B-loaded shell aluminum fragments occurring above 10 grains is 27.

The average total number of TNT-loaded shell aluminum fragments occurring above 10 grains is 34,

A graphical representation of the data given in the preceding three paragraphs is shown in Figure 1.

A curve of percent average cumulative weight of steel shell fragments versus group number for the TNT and Comp B-loaded shell, respectively, is shown in Figure 2.

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The "Percent average cumulative weight" is based on the average weight of fragments (per group number) of each group of 3 projectiles on the inclosed data sheets.

By definition, the average cumulative weight of fragments equals the average weight of fragments in a group, plus the average weight of fragments in all preceding groups. The percent average cumulative weight of fragments is defined as the ratio of the average cumulative weight to the average weight of the empty shell.

Average total weight of Comp B-loaded steel shell fragments occurring between 10 and 50 grains divided by weight of empty shell X 100 = 44%

Average total weight of TNT-loaded steel shell fragments occurring between 10 and 50 grains divided by weight of empty shell X 100 = 37.5%

The statement, made above, that effective lethality is obtained only with fragments occurring over 10 grains in size, and also the statement that fragments in the weight range of 10 to 50 grains constitutes the optimum casualty producing size of fragment, is based entirely on the criterion established by Watertown Arsenal as given in 1st Indorsement, 3-2-54, Watertown Arsenal to Picatinny Arsenal, ORDBE-L 471.2/1824, ORDBB 471.14/10-122, subject: "Fragmentation Characteristics of Shell and Test Cylinders of Case and Forged Steels (Project TA1-1546D)".

However, if the assumptions relative to the nature of terrain, effect of fragment velocities, and wound ballistics contained in various Ballistic Research Laboratories Reports, by: T. Sterne, et al, are followed, the conclusions probably would be changed and the shell and explosive combinations giving fine degrees of fragmentation might be moved up into higher categories of preference. This involved decisions to be made only after consideration by higher echelons, such as Service Board, ORO, and WSEG, and probably would require acquiring information on fragmentation, velocity and distribution patterns which is presently not available.

Regardless of which of above criteria are used, however, it appears that the Comp B-loaded Type BD-106-1 shell yielded fragmentation properties slightly superior to those of the TNT-loaded Type BD-106-1 shell. Both TNT and Comp B-loaded Type BD-106-1 shell metal parts yielded fragmentation characteristics superior to those of similarly loaded Shell, HE, 60 mm, T24 Metal Parts as reflected in Picatinny Arsenal Fragmentation Report No. 279

G. R. FLARTEY
George R. Flartey

JOHN D. ARMITAGE
Col, Ord Corps
Director, SFAL

DISTRIBUTION LIST FOR PA FRAGMENTATION REPORT NO 287

	Copy No.
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PICATINNY ARSENAL FRAGMENTATION TEST

Projectile: Mortar 60mm Boat Tail Folding Fin Steel, Carbon, Bar Stock; FS 1020 Spec. QQ-S-633 Mfgd by Budd Co

Test Record No: 2340

Explosive Filler: TNT Design BD-106-1

Sheet 1 of 4

Type Fuze: P.D. M52 Mod. Initiated with an Eng. Corps Blasting Cap.

Date: 6 May 1954

Size of Box: 8" x 8" x 16" 1/2" Pine

Recovery Medium: Sawdust #8 Mesh Screen and Magnetic Separator

			PROJECTILE NO. 1			PROJECTILE NO. 2	
Requested by Mr. G. Flartey			Steel	Alum		Steel	Alum
Wt. Empty Lbs.			2.68	.78		2.68	.78
Wt. Loaded Lbs.			4.30			4.29	
Number and Weight of Recovered Fragments	No. 0 Group	Through a 10 Mesh Screen (U. S. Std Sieve Series)					
	0 to ½ Grs. Not Counted	Wt. Lbs.	.06	.01		.05	.01
	No. 1 Group	No.	751	54		712	63
	½ to 2 Grs.	Wt. Lbs.	.12	.01		.12	.01
	No. 2 Group	No.	440	3		343	74
	2 to 5 Grs.	Wt. Lbs.	.20	.03		.17	.04
	No. 3 Group	No.	243	25		198	22
	5 to 10 Grs.	Wt. Lbs.	.25	.02		.21	.02
	No. 4 Group	No.	251	20		219	17
	10 to 25 Grs.	Wt. Lbs.	.59	.04		.50	.04
	No. 5 Group	No.	107	7		91	10
	25 to 50 Grs.	Wt. Lbs.	.54	.04		.48	.05
	No. 6 Group	No.	30	6		28	7
	50 to 75 Grs	Wt. Lbs.	.26	.05		.25	.06
	No. 7 Group	No.	28	2		37	1
	75 to 150 Grs.	Wt. Lbs.	.43	.02		.62	.01
	No. 8 Group	No.	8			9	1
	150 to 750 Grs.	Wt. Lbs.	.22			.24	.09
	No. 9 Group	No.					
	750 to 2500 Grs.	Wt. Lbs.					
	No. 10 Group	No.		1			1
	2500 and Larger	Wt. Lbs.		.54			.43
Total No.			1858	173		1637	185
Total Wt. Lbs.			2.67	.76		2.64	.76
% of Fragments Recovered			99.6	97.4		98.5	97.4
Photo No.			M44781			M44782	

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PICATINNY ARSENAL FRAGMENTATION TEST

Projectile: same

Explosive Filler: TNT Design BD-106-1

Type Fuze:

Size of Box:

Recovery Medium:

Test Record No: 2340

Sheet 2 of 4

Date: 6 May 1954

			PROJECTILE NO. 3				
			Steel	Alum			
Wt. Empty Lbs.			2.68	.78			
Wt. Loaded Lbs.			4.30				
Number and Weight of Recovered Fragments	No. 0 Group 0 to ½ Grs. Not Counted	Through a 10 Mesh Screen (U. S. Std Sieve Series) Wt. Lbs.	.05	.01			
	No. 1 Group ½ to 2 Grs.	No.	725	22			
		Wt. Lbs.	.11	.01			
	No. 2 Group 2 to 5 Grs.	No.	387	58			
		Wt. Lbs.	.18	.03			
	No. 3 Group 5 to 10 Grs.	No.	225	26			
		Wt. Lbs.	.23	.03			
	No. 4 Group 10 to 25 Grs.	No.	225	14			
		Wt. Lbs.	.49	.03			
	No. 5 Group 25 to 50 Grs.	No.	90	9			
		Wt. Lbs.	.43	.05			
	No. 6 Group 50 to 75 Grs.	No.	25	6			
		Wt. Lbs.	.21	.05			
	No. 7 Group 75 to 150 Grs.	No.	32	1			
		Wt. Lbs.	.51	.01			
	No. 8 Group 150 to 750 Grs.	No.	17				
		Wt. Lbs.	.46				
	No. 9 Group 750 to 2500 Grs.	No.					
		Wt. Lbs.					
	No. 10 Group 2500 and Larger	No.		1			
		Wt. Lbs.		.54			
Total No.			1726	137			
Total Wt. Lbs.			2.67	.76			
% of Fragments Recovered			99.6	97.4			
Photo No.			M-783 6				

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PICATINNY ARSENAL FRAGMENTATION TEST

Projectile: same

Explosive Filler: Comp B Design BD-106-1

Type Fuze:

Size of Box:

Recovery Medium:

Test Record No: 2340

Sheet 3 of 4

Date: 6 May 1954

			PROJECTILE NO. 1			PROJECTILE NO. 2	
			Steel	Alum		Steel	Alum
Wt. Empty Lbs.			2.68	.78		2.68	.78
Wt. Loaded Lbs.			4.36			4.35	
Number and Weight of Recovered Fragments	No. 0 Group	Through a 10 Mesh Screen (U. S. Std Sieve Series)					
	0 to ½ Grs. Not Counted	Wt. Lbs.	.12	.01		.10	.01
	No. 1 Group	No.	1084	38		987	87
	½ to 2 Grs.	Wt. Lbs.	.17	.02		.15	.01
	No. 2 Group	No.	523	68		616	57
	2 to 5 Grs.	Wt. Lbs.	.25	.03		.28	.02
	No. 3 Group	No.	336	22		332	29
	5 to 10 Grs.	Wt. Lbs.	.34	.02		.34	.03
	No. 4 Group	No.	280	14		311	13
	10 to 25 Grs.	Wt. Lbs.	.60	.03		.69	.03
	No. 5 Group	No.	109	4		92	5
	25 to 50 Grs.	Wt. Lbs.	.54	.02		.45	.03
	No. 6 Group	No.	22	9		12	7
	50 to 75 Grs.	Wt. Lbs.	.19	.07		.10	.06
	No. 7 Group	No.	26			27	
	75 to 150 Grs.	Wt. Lbs.	.38			.41	
	No. 8 Group	No.	2			4	
	150 to 750 Grs.	Wt. Lbs.	.05			.11	
	No. 9 Group	No.					
	750 to 2500 Grs.	Wt. Lbs.					
	No. 10 Group	No.		1			1
	2500 and Larger	Wt. Lbs.		.54			.54
Total No.			2382	206		2381	199
Total Wt. Lbs.			2.64	.74		2.63	.73
% of Fragments Recovered			98.5	94.8		98.1	93.5
Photo No.			M44784			M44785	

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PICATINNY ARSENAL FRAGMENTATION TEST

Projectile: same

Explosive Filler: Comp B Design BD-106-1

Type Fuze:

Size of Box:

Recovery Medium:

Test Record No: 2340

Sheet 4 of 4

Date: 6 May 1954

			PROJECTILE NO. 3				
			Steel	Alum			
Wt. Empty Lbs.			2.68	.78			
Wt. Loaded Lbs.			4.37				
Number and Weight of Recovered Fragments	No. 0 Group	Through a 10 Mesh Screen (U. S. Std Sieve Series)					
	0 to ½ Grs. Not Counted	Wt. Lbs.	.08	.01			
	No. 1 Group	No.	1117	136			
	½ to 2 Grs.	Wt. Lbs.	.16	.02			
	No. 2 Group	No.	488	60			
	2 to 5 Grs.	Wt. Lbs.	.22	.03			
	No. 3 Group	No.	313	37			
	5 to 10 Grs.	Wt. Lbs.	.32	.04			
	No. 4 Group	No.	319	12			
	10 to 25 Grs.	Wt. Lbs.	.69	.03			
	No. 5 Group	No.	100	4			
	25 to 50 Grs.	Wt. Lbs.	.48	.03			
	No. 6 Group	No.	27	9			
	50 to 75 Grs.	Wt. Lbs.	.23	.07			
	No. 7 Group	No.	26				
	75 to 150 Grs.	Wt. Lbs.	.42				
	No. 8 Group	No.	2				
	150 to 750 Grs.	Wt. Lbs.	.05				
	No. 9 Group	No.					
	750 to 2500 Grs.	Wt. Lbs.					
	No. 10 Group	No.		1			
	2500 and Larger	Wt. Lbs.		.53			
Total No.			2392	259			
Total Wt. Lbs.			2.65	.76			
% of Fragments Recovered			98.8	97.4			
Photo No.			M44786				
			8				

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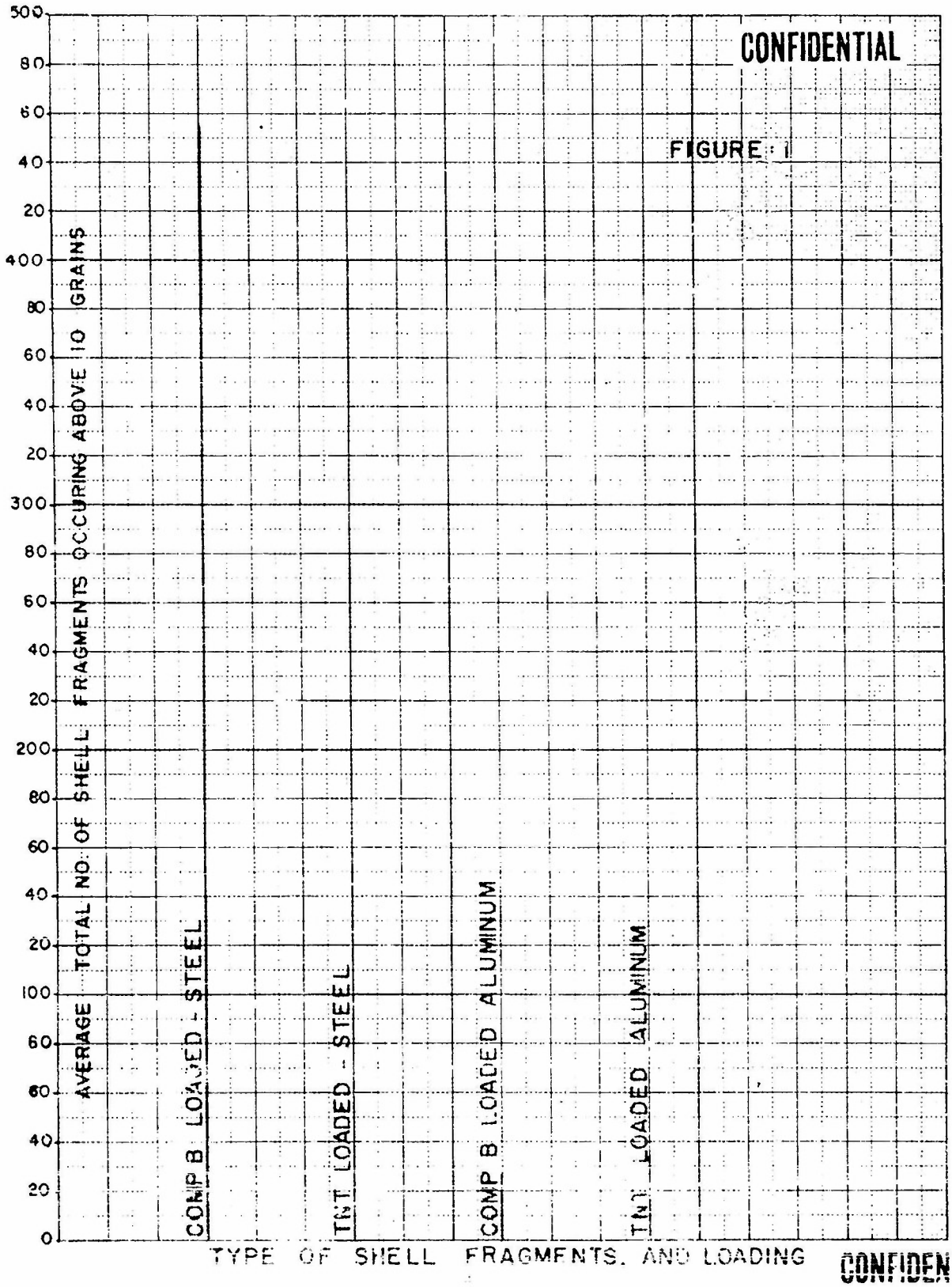
Reviewed by L. D. Bercow
Chief, Proof Testing Unit

Approved by L. F. Page
Chief, Testing Section

Prepared by J. Smalinski

FIGURE 1



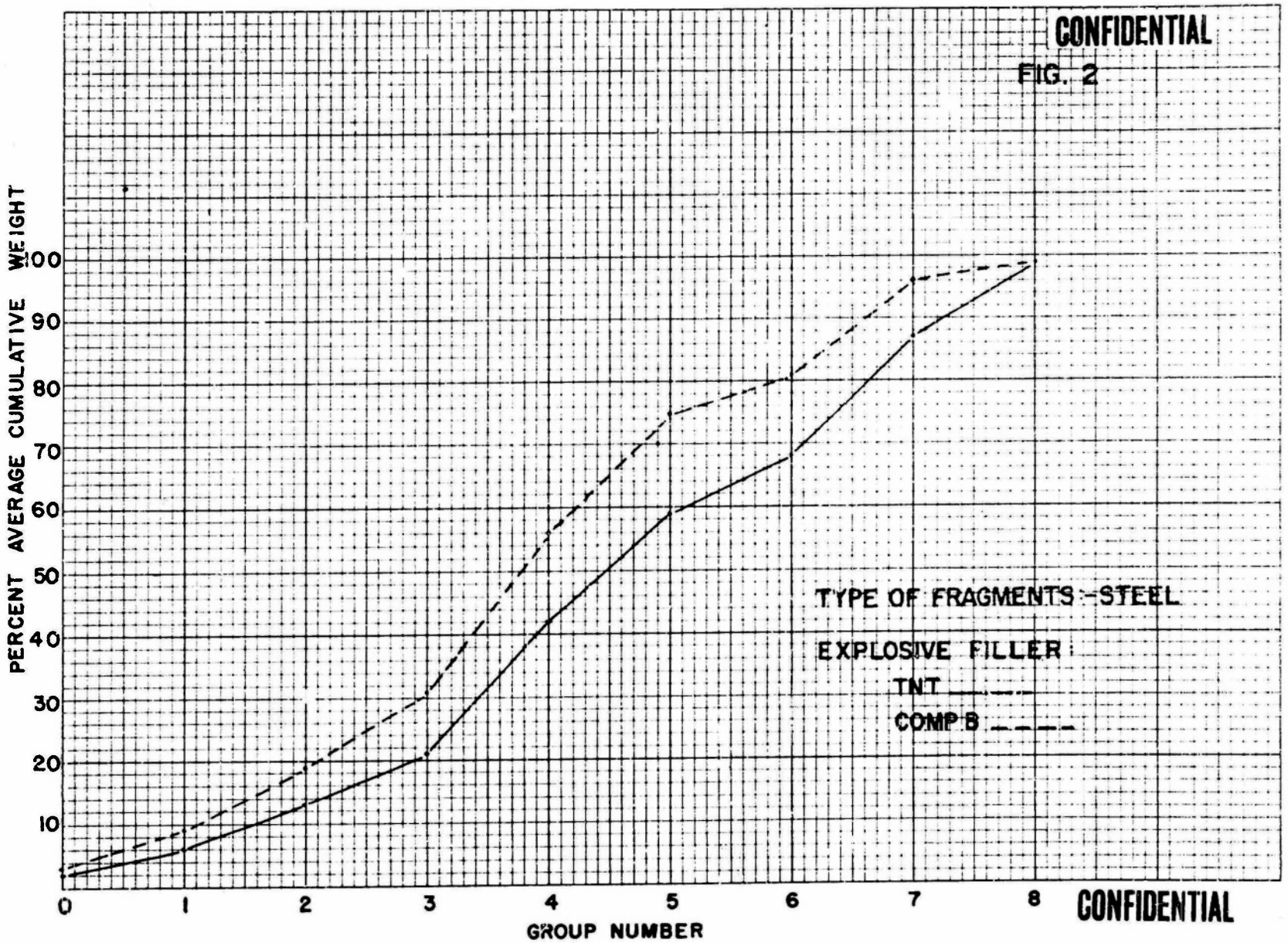

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FIG. 2
PERCENT AVERAGE CUMULATIVE WEIGHT
100
90
80
70
60
50
40
30
20
10
0
1
2
3
4
5
6
7
8
GROUP NUMBER
TYPE OF FRAGMENTS - STEEL
EXPLOSIVE FILLER
TNT
COMP B
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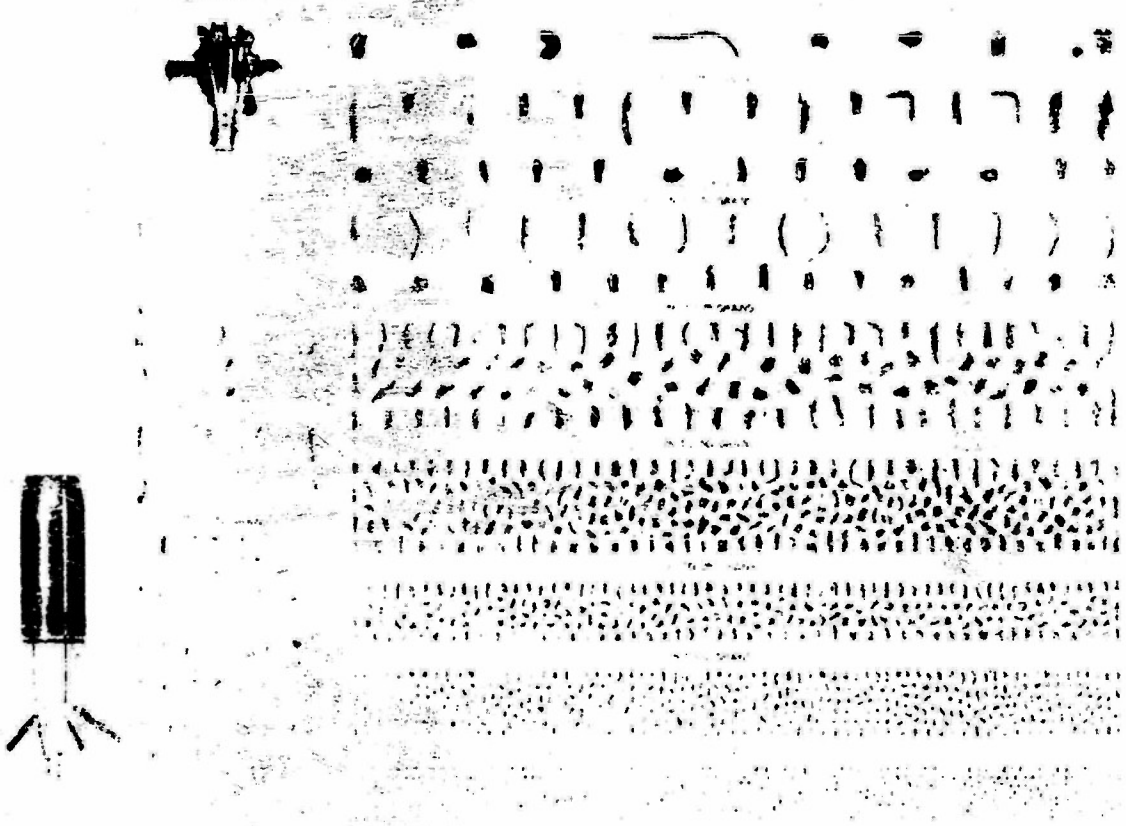

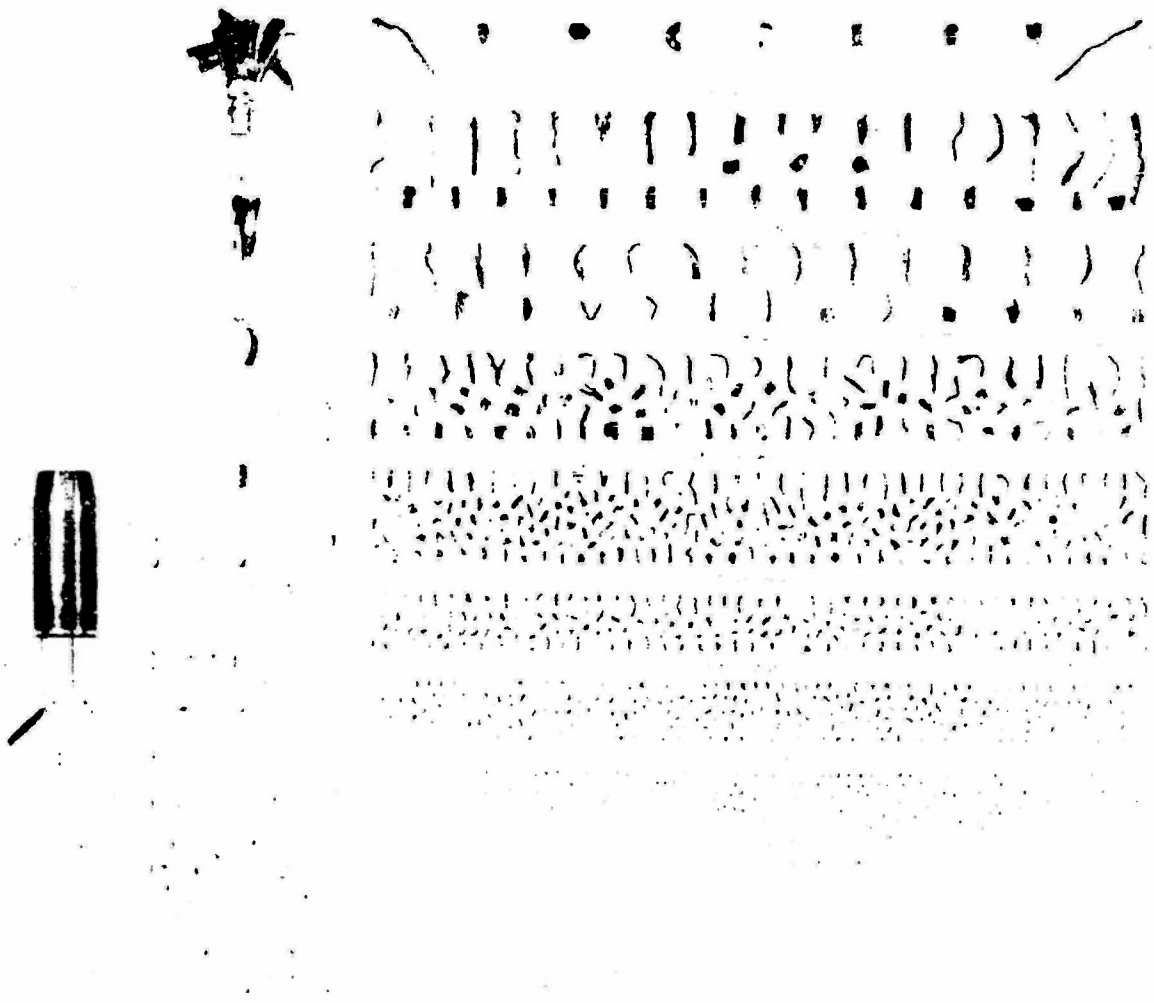

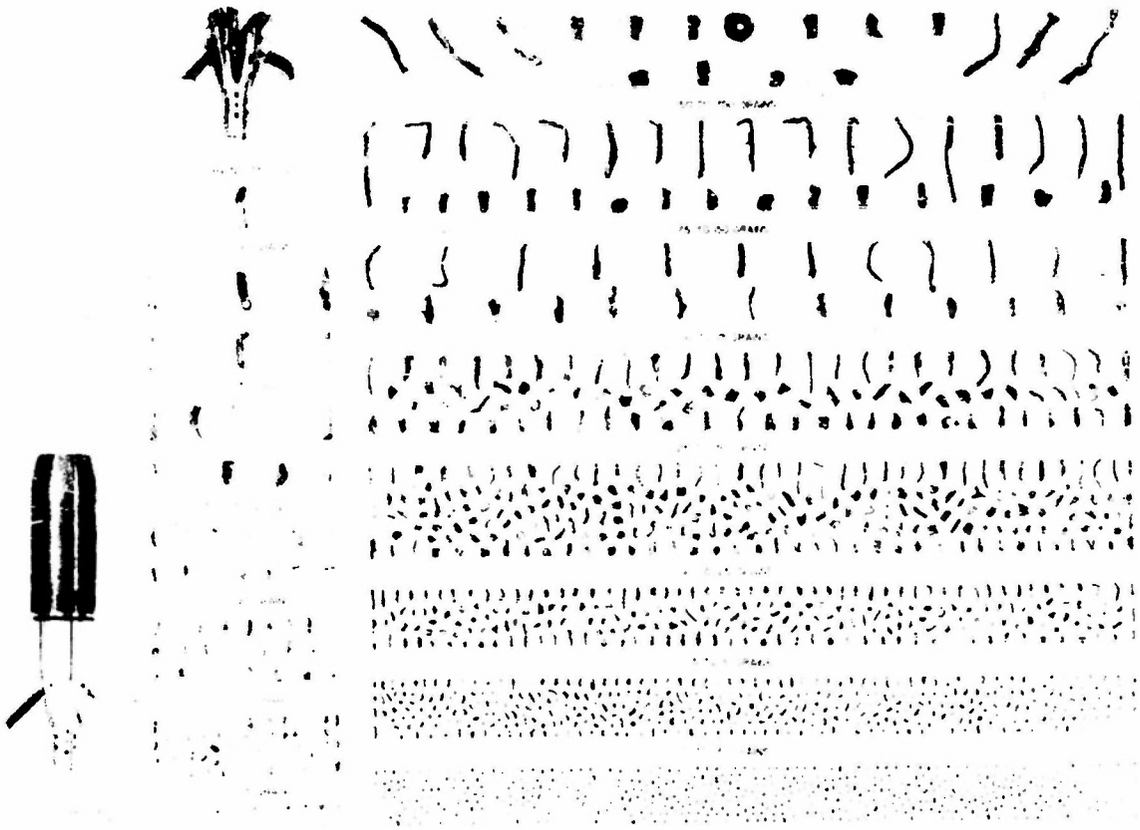

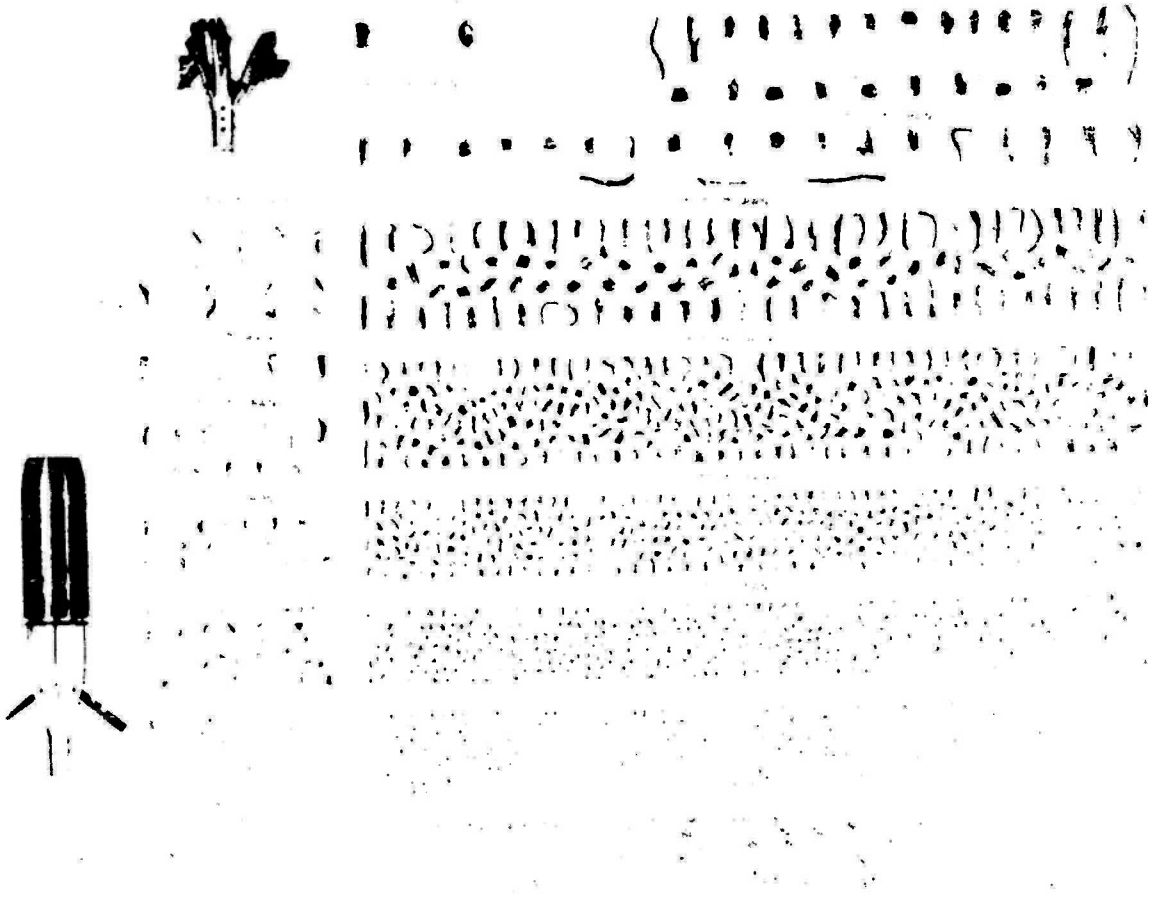

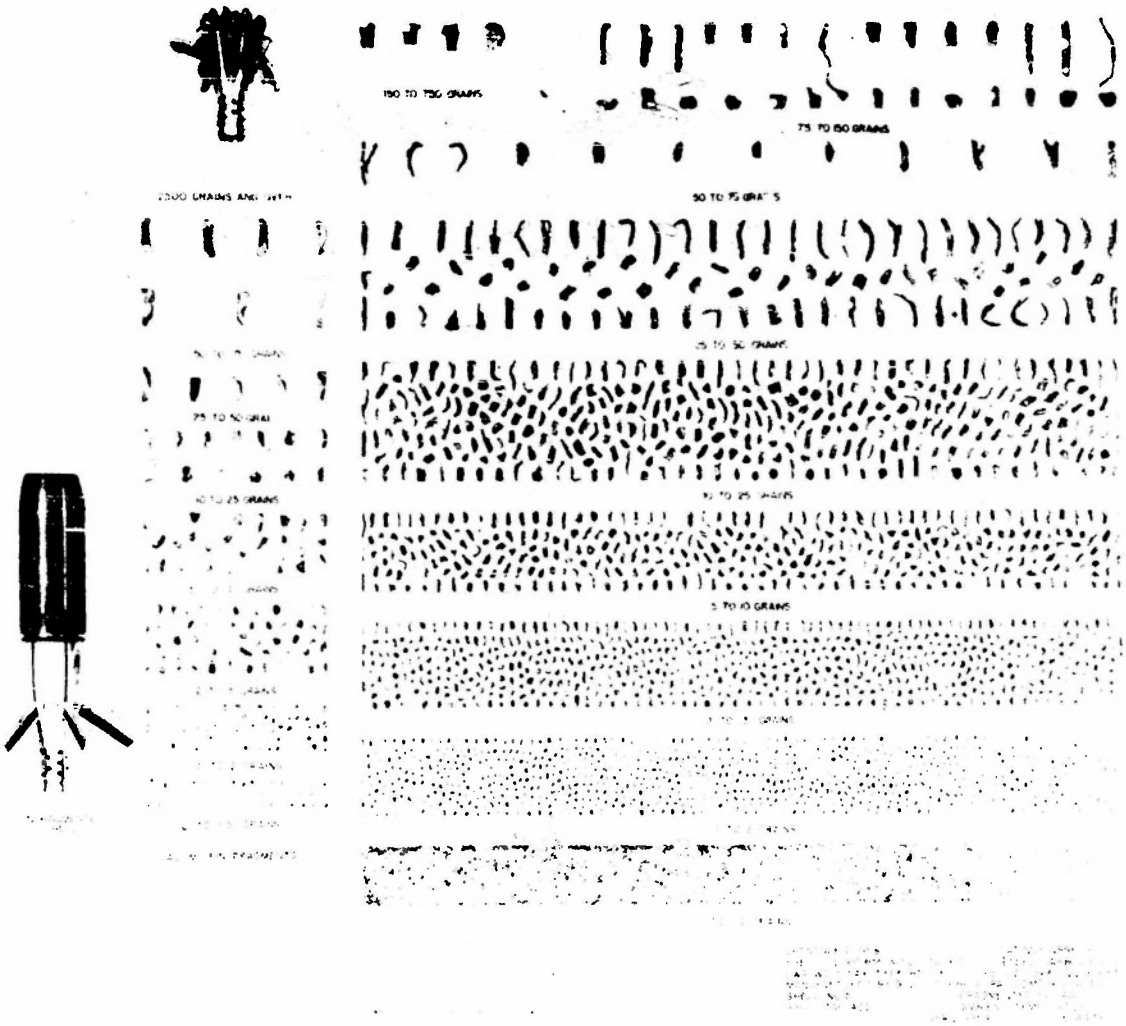
150 TO 750 GRAINS
75 TO 150 GRAINS
50 TO 75 GRAINS
25 TO 50 GRAINS
10 TO 25 GRAINS
5 TO 10 GRAINS

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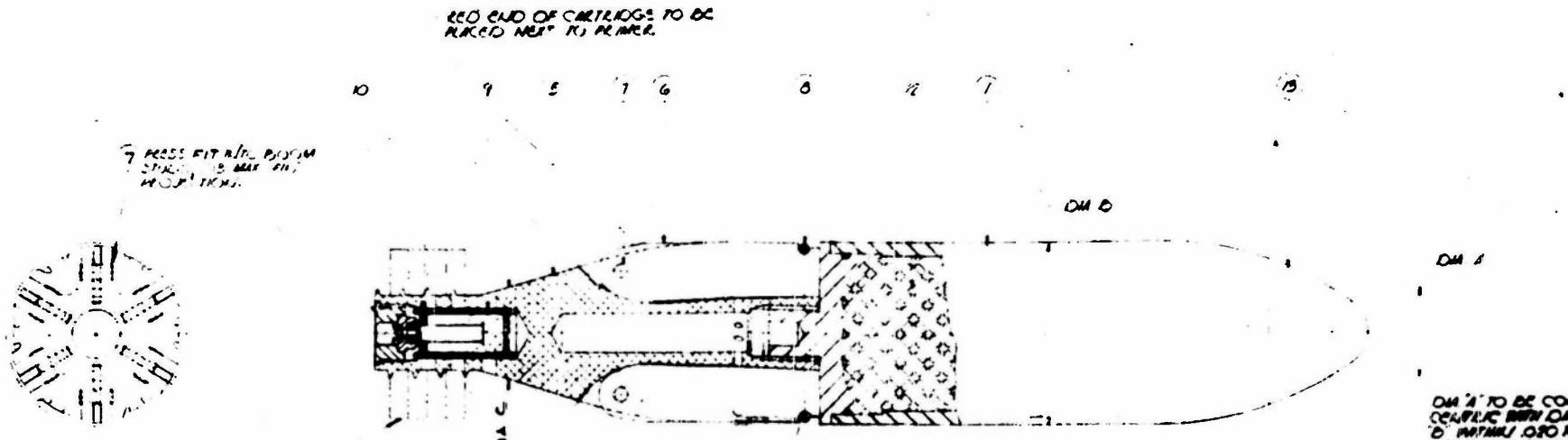
WD-5154X



NOTES

1. APPLY ITEM 11 TO THE THREADS OF ITEM 9 WHEN BOOM IS ASSEMBLE TO BODY WHEN REQ'D.

PROC. MOUNTING PADS. FOR ALL PADS.

ITEMS HAVING NO NUMBER IN THE QUANTITY COLUMN ARE COMPONENTS OF THE PRECEDING SUB ASS'Y LISTED BELOW THEM.

		1			FUSE	1-191	BY ORD	13	
		-			FILLER			12	
	WP-1994	-			THREAD SEALING COMPOUND			11	
	IN-2-49	1			PRIMER, PERCUSSION M37		BY ORD	10	
	13-19-78A	1			CARTRIDGE, IGNITION ASS'Y	M501	BY ORD	9	
	WP-5181X	1			O RING			8	
	WP-5155X	6			PIN			7	
	WP-5156X	6			PIN			6	
	WD-5155X	1			BOOM			5	
	WD-5157-A	-		1	SCREW & NUT, ELAS			4	
	WD-5157-B	-		1	ADAPTER			3	
	WD-5154-A	-		1	BODY			2	
	WD-5154-A	1			BODY ASS'Y			1	
	PIECE NO. UNIT	QTY.			DESCRIPTION CONFIDENTIAL	MATERIAL			

USED ON — JOB 6000-004

PIECE NO. UNIT — QTY.

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THE BUDD COMPANY
RED LION PLANT
PHILADELPHIA 18, PA.

TITLE: 60MM MORTAR ROUND BOAT TAIL, FOLDING FIN

DRAWING NO. WD-5154X

SCALE: 1/1

DATE: 10-3-53

DRAWN: S.P. ALLEGRON

CHECKED: F.O.V.

APPROVED:

BD-R06-1

2	PART No. WAS AN6230-8	
1	ADDED PER ECN	

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WD-5196X

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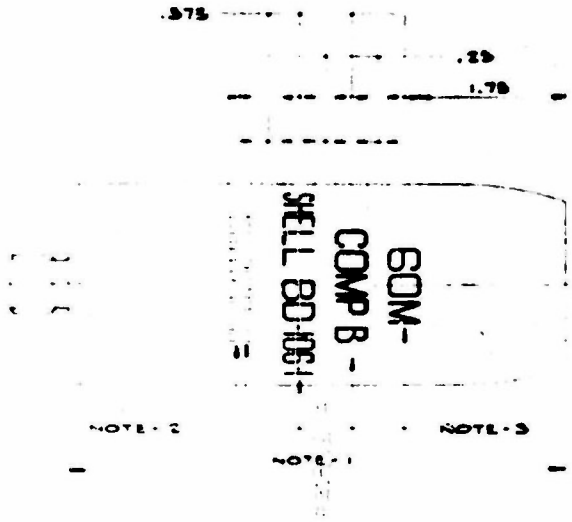
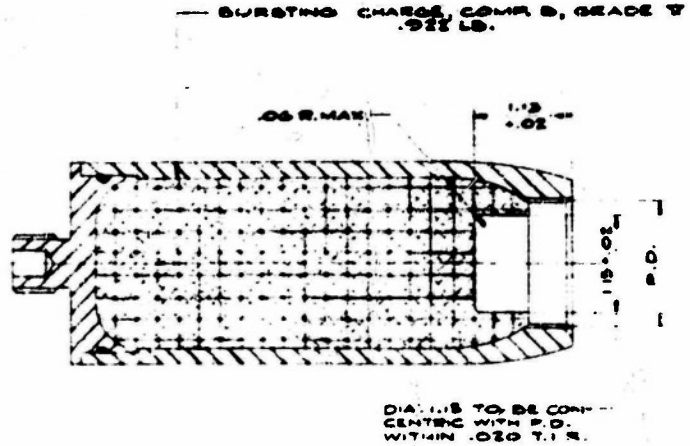


PAINTING AND MARKING DIAGRAM



SHELL LOADING ASSEMBLY

NOTES

1. RETOUCH SHELL BODY WITH OLIVE DRAB ENAMEL WHERE DAMAGED.
2. MARK LOT NO DATE (MONTH AND YEAR) LOADED
3. MARK WITH YELLOW STENCIL INK.
4. MEAN VOLUME OF CHARGE CAVITY 5.575 CU IN.

USED ON	JOB	LEGEND	PIECE NO / UNIT	QTY	LEGEND	PIECE NO / UNIT	QTY	PLANT CODE	LABOR	DESCRIPTION	MATERIAL	ITEM	REV
										CONFIDENTIAL			

THE BUDD COMPANY
RED LION PLANT
PH. ADELPHIA 18 PA.

TITLE: LOADING & MARKING DWG 60 MM. WB-5152X COMP B.

DRAWING NO: WD-5196X

DRAWN: A. WAGNER 2-5-54 | CHECKED | APPROVED | APPROVED

1 REL. FOR EXP ORDER

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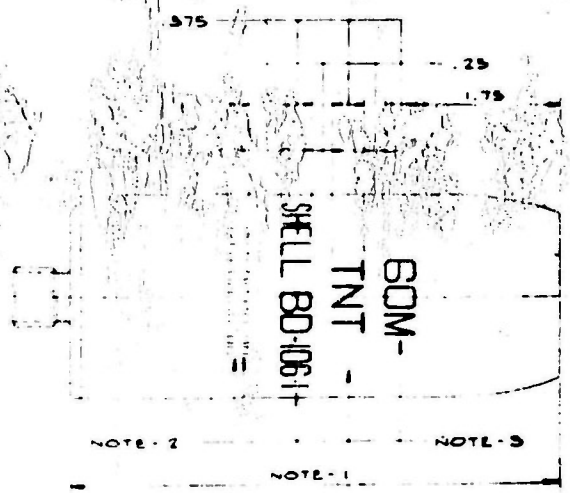
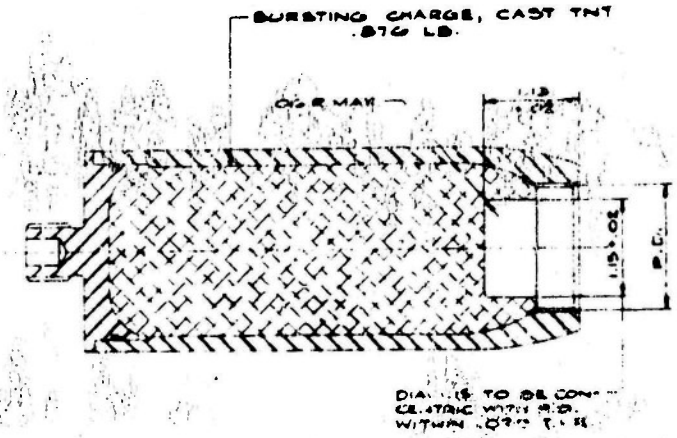
WD-5197X



PAINTING AND MARKING DIAGRAM



SHELL LOADING ASSEMBLY

NOTES:

1. RETOUCH SHELL BODY WITH OLIVE DRAB ENAMEL WHERE DAMAGED.
2. MARK LOT NO., DATE (MONTH AND YEAR) LOADED.
3. MARK WITH YELLOW STENCIL INK
4. MEAN VOLUME OF CHARGE CAVITY 19.375 CU. IN.

USED ON	JOB	ORDER NO. SHOP	QTY.	ORDER NO. LIST	QTY.	DESCRIPTION	MATERIAL
						CONFIDENTIAL	

THE BUDD COMPANY
RED LION PLANT
PHILADELPHIA 15, PA.

TITLE: LOADING & MARKING DWG. 60 MM, WD-5197X TNT

DRAWING NO. WD-5197X

DATE: 2-5-54

DO NOT SCALE DRAWINGS REPORT ALL CHANGES AND ERRORS TO ENGINEERING DEPARTMENT

SECTION D-D

SECTION C-C

20